VASCULAR FLORA OF C. BICKHAM-DICKSON/RED RIVER EDUCATION AND RESEARCH PARK, CADDO PARISH, LOUISIANA: AN OXBOW LAKE COMMUNITY, WITH COMMENTS ON EXOTIC/NATIVE SPECIES RATIOS

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ABSTRACT

A floristic inventory was conducted as part of a biological assessment of the C. Bickham-Dickson/Red River Education and Research Park, Caddo Parish, Louisiana. The goal was to provide a baseline checklist of the flora of this oxbow lake area. An additional goal was to provide an overview of disturbance history and the exotic species of the flora. The flora consists of 318 species of which 68 (21%) are not natives.

RESUMEN

Se realizó un inventario florístico como parte de una evaluación biológica del C. Bickham-Dickson/Red River Education and Research Park, Caddo Parish, Louisiana. El objetivo fue realizar un listado base de la flora de esta área lacustre. Un objetivo adicional fue aportar una visión de conjunto de la historia de las perturbaciones de la flora y especies exóticas. La flora consiste en 318 especies de las que 68 (21%) no son nativas.

INTRODUCTION

River systems have undergone drastic modification since the beginning of agriculture. For example, the Nile and its flood plain have been under intense human pressure and, consequently, modification for thousands of years (De Villiers 2000). In the New World, both Native Americans and Europeans often selected rivers and their floodplains for farms, plantations, and cities. Whether we speak of Cahokia or St. Louis, we can see that these sites were desirable and came under human occupation and thus modification early on. Today, there are few major river systems or even parts of major river systems that approach pristine conditions (Noss et al. 1995; Outwater 1996; DeVilliers 2000).

The Red River is no exception. Caddo Indians inhabited its floodplain and followed later by European settlers and their African slaves (Perttula et al. 2008). The first ecologist/botanist to study the Red River was Peter Custis, naturalist on the ill-fated 1806 Red River Expedition (Flores 1984; MacRoberts et al. 1997; MacRoberts & MacRoberts 2004; Hardy 2008). Only two of Custis' plant specimens survive, but the descriptions provided by both Custis and Thomas Freeman (leader of the expedition) are tantalizing: prairies, swamps, cedar forests, and canebreaks lined the Red River. The next important ecological information about the Red River's ecology was the land survey of the 1830s (MacRoberts & MacRoberts 2005). A recent conference, *The Freeman and Custis Red River Expedition of 1806: Two Hundred Years Later,* focused attention on the Red River and Upper West Gulf Coastal Plain and concluded that very little is known biologically about it and that no inclusive study has been undertaken to elucidate the ecology of this system since the early nineteenth century (Bragg 2008; MacRoberts & MacRoberts 2008).

In this paper, we undertake to describe the floristics of the C. Bickham-Dickson/Red River Education and Research Park (Park hereafter), a highly modified oxbow system on the Red River floodplain. We also

briefly consider the relationship between site disturbance and native/non-native (exotic) species ratios: "non-native" or "exotic" referring to introduced species from outside the United States.

There were very few exotic species in North America in 1491. Only cultivars brought to North America from Central America and Mexico were imports. Now, 20 to 35 percent (depending on author) of the 20,000 odd species found in North America are exotics from all parts of the world (Stuckey & Barkley 1991).

While there is an extensive literature on exotic species (Elton 1958; Simberloff 2004; Sax et al. 2005) and much data on the relationship between percentage of exotic species in a flora and the overall size of the flora, there is little quantitative data and even less experimental data on the relationship between disturbance history and the exotic/native flora. Nonetheless, it is widely recognized that highly disturbed sites such as cities and urban parks have a high percentage of exotics (ca. 20–60%); whereas undisturbed sites have much lower percentages (ca. 0–10%) (Fox & Fox 1986; McIntyre & Lavorel 1994; Basinger et al. 1997; Stalter et al. 1997; Stapanian et al. 1998; Lonsdale 1999; McKinney 2002, 2006; Harcombe et al. 2007). Percentage of exotics, therefore, can be used as an indicator of degree of site disturbance (Gilliam 2007).

STUDY SITE

The Red River originates in the Great Plains and flows 2,200 km east and southeast until it reaches the Mississippi River in central Louisiana. Red and brownish red silt and clay particles, eroded from mainly Triassic and Permian rock, give the river its distinctive color. From north central Texas to the Mississippi River, the river is sluggish with a low-lying, flat, extensive, Pleistocene/Holocene floodplain valley five to thirty km wide with oxbows, sloughs, and backwater swamps. Flanking the floodplain at its lower reaches are woodlands dominated by oak, pine, and hickory. As the glaciers receded and sea levels rose, the gradient of the river lessened, causing it to braid and meander widely, resulting in deposition of alluvium that we see today. The floodplain slope is gradual (Newkirk & Mueller 1980; Triska 2008).

Hunters entered the Red River area at least 12,000 years ago near the end of the last glaciation, long before the present climate and biota were established. Horticulture came much later, probably no more than 3000 years ago. The effect of Native Americans on the ecology is not known, but there is considerable debate on this matter (e.g., Mann 2005). The Red River was first seen by European explorers in the sixteenth century. Its lower reaches were colonized by the French in the eighteenth century, but because the "Great Raft"—an immense logjam—blocked the river, its upper part was not fully explored until the nineteenth century (Flores 1984). In 1806, the Freeman and Custis expedition went through and around the raft to near the present day border of Oklahoma and Arkansas (Flores 1984; MacRoberts & MacRoberts 2004; Hardy 2008). Marcy and McClellan (1854) completed the exploration of the river in the mid-nineteenth century. The raft, which extended in the mid-eighteenth century from Natchitoches to Shreveport was cleared by the 1850's but immediately reformed above Shreveport and grew by accumulation of driftwood to almost the Arkansas border by 1873. The raft dammed the river, causing extensive flooding of low-lying areas and the creation of raft-lakes. Cottonwood, cypress, and red cedar apparently made up the bulk of the raft, and older sections were covered with herbaceous plants and shrubs. The raft was finally completely cleared by 1873, with the result that raft-lakes drained and the River was navigable. Rapid exploitation of the floodplain and the establishment of farms, plantations, towns, and cities followed (Humphreys 1971; Flores 1984; Triska 1984, 2008; Bagur 2001).

Over the last two centuries, the river and its floodplain ecosystems have undergone drastic modification. Much of the landscape was converted to farms and plantations and eventually the river was modified by leveeing, straightening, and damming. The floodplain was severely modified by agriculture and urban sprawl. The once continuous forest of varied communities that covered hundreds of thousands of hectares is now virtually gone. Cypress swamps, willow riverbank shrublands, and cottonwood forests hang on while some floodplain communities such as cedar forests, cane brakes, and prairies have vanished entirely (MacRoberts et al. 1997; MacRoberts & MacRoberts 2008a).

Although floodplains in general have received substantial phytogeographical and ecological attention

and there are numerous generalized descriptions and classifications according to hydrologic conditions, soils, and vegetation (e.g., Sharitz & Mitsch 1993; Messina & Conner 1998; Mitsch & Gosselink 2000), the Red River floodplain is poorly known, especially floristically (see Newkirk & Mueller 1980). Aside from checklists of parishes and communities along the Red River, its last floristic survey was in 1806. It has never been the subject of an ecological assessment (MacRoberts & MacRoberts 2008b). The most important literature dealing with local ecology is small. MacRoberts (1979) and MacRoberts and MacRoberts (2006) produced a flora of Caddo Parish. Van Kley and Hine (1998) described the wetland vegetation of Caddo Lake—a remnant raft-lake. There have been several studies of floodplain forests in eastern Texas (e.g., see literature in Mundorff 1998). MacRoberts and MacRoberts (2005), using original land plats, described the 1830s woody vegetation of Caddo Parish. Diggs et al. (2006) and Van Kley (2006) summarized the community types of eastern Texas and western Louisiana. Ware (1956) briefly described the vegetation on a sand bar near Natchitoches, and Teague and Wendt (1994), concentrating on Bossier and Caddo parishes, conducted the first parish-wide comprehensive survey of high quality natural communities in Louisiana, only two of which were floodplain communities. Two non-quantified reports round out the list: Palmer (1923) provided an anecdotal report of the Red River forest at Fulton, Arkansas, and the Henderson State University Biology Department (1979) prepared a modest "biological inventory of the Red River waterway" for the Corps of Engineers.

The Park is located between the campus of Louisiana State University in Shreveport and the Red River (Sexton-Gordon 2004) (Fig. 1). It is 236 ha and includes an 81 ha oxbow lake created in the spring of 1945 by the change in course of the river during a flood. The Park ranges in elevation from about 44 to 49 m above sea level. It periodically floods and its oxbow lake is only a few meters deep. To the west is a man-made levee with adjacent barrow-pit and to the east is the Red River, which is now impounded and is in reality a linear lake. Natural levees occur adjacent to the river and the oxbow. The floodplain is about 15 km wide at this point. The Park was once within the area of the Great Raft. The part of the raft adjacent to the Park was cleared between 1833 and 1837.

The Park shows the classic geologic structure of river meander systems and oxbow lakes (Sharitz & Mitsch 1993). The river channel meanders through the floodplain, transporting, eroding, and depositing alluvial sediments. Natural levees adjacent to the channel result from deposition of coarser sands when floods overtop the banks. Point bars form from sedimentation on the convex side of river curves and soon support vegetation, which stabilizes the soils. At the same time, on the concave (cut bank) side of the river the relatively fast water moving cuts away the bank. As the river migrates across the floodplain, meander scrolls (ridges and swales) form, giving the area appreciable topography. Oxbow lakes form when the meander cuts off at its neck, and a new channel forms. The deposited soils are generally described as "riverwash:" "recently deposited, slightly acid to moderately alkaline sand, silt, and clay." "Most of the material is sandy, but there are many thin layers of clay and silt. The profiles are not uniform from place to place. At frequent intervals during floods, fresh material is deposited or several feet of material is washed away. In this manner the upper layers change from one year to another. The slopes are uneven. The slope range is generally from less than 1 percent to 3 percent, but there are some short slopes of as much as 5 percent" (U.S.D.A. Soil Conservation Service 1959:41–42).

The land that encompasses the Park first came under individual ownership with the 1801 Spanish Land Grant to Francois Grappe, son of a French father and Caddoan mother, born at La Harpe's Post north of the Great Bend probably in what today is Bowie County, Texas. Grappe was a trader, interpreter, guide, and cattle runner. He was centrally involved in the Freeman and Custis Red River expedition as guide and interpreter or supplier of interpreters and guides to the ill-fated expedition. The grant given to Grappe consisted of four leagues along the Red River in what is today south Caddo Parish. The grant was recognized in 1835 in the Caddo Cession and passed to Grappe's sons, who in turn sold it to Jahiel Brooks, Caddo Agent, who in turn managed to lose it to creditors by the 1850's. Neither Grappe nor his sons ever lived on this land nor is there any evidence that they exploited it in any way. The first white settler of what is today the

Fig. 1. Aerial view of Bickham-Dickson/Red River Education and Research Park and surrounds including Louisiana State University in Shreveport. Photo by Harris Photography, permission of Jennifer LaPierre, Media and Public Relations, LSUS.

Park appears to have been Samuel Norris. Norris, since the 1820's, had lived on "Rush Island"—a part of the Grappe claim, either in the Park or just south of it. What Norris used the land for is not entirely clear but apparently hogs, cattle, and farming were involved. His claim was eventually disputed and it too went to creditors at the same time as did Brooks'. By the 1890s, the land had become part of the Fullilove Plantation (O'Pry 1928; Flores 1984; Henrici 1985). The site has subsequently been cleared, grazed, plowed and planted with forage crops, and used as a horse stables and riding area.

In 1839 at the time of the General Land Office land survey, the Red River was a little to the east of its present position at the Park. By 1890, it had meandered halfway across the Park and was moving steadily west. In 1945, its channel ran along what is now the oxbow lakes in the Park. But during the spring of that year, the river overflowed and cut a new channel through the narrow neck of land to the east of the park and established its present channel (Advisory Committee Report 2002). Thus, geologically the area of the Park is not old. With the exception of those soils on its extreme western edge, all the soils have been reordered over the last two centuries.

Construction of the Red River Navigation Project, which was authorized by Congress through the Rivers and Harbors Act of 1968, led to the development of five locks and dams downstream. When the Corps of Engineers completed the last structure, Lock and Dam 5 about 30 km downstream in late 1994, the average river level at the Park was increased to a post-construction pool stage of 147 feet above mean sea level. The lake level is currently erratic and depends on river flood stage and other internal factors.

Teague and Wendt (1994) give additional background information on climate, geology, and history of the area. Prior to the construction of locks on the river in the 1990s, July to December was the period of lowest water, and January to June the period of highest water. Rainfall is approximately 115 cm per annum.

The City of Shreveport and the State of Louisiana jointly purchased the site in 1980 and named it C.

Bickham Dickson Park. The Park was used solely for recreational activities such as sport fishing and boating until the mid-1980s when Louisiana State University in Shreveport began biological and geological research at the site. In 2000, the City entered into an agreement with Louisiana State University in Shreveport under which the University would be allowed to utilize the park as a "living laboratory" for natural resource education and research. Under the agreement, Louisiana State University in Shreveport would manage the Park as Red River Education and Research Park. Research at the Park, which also includes the development of innovative environmental monitoring technologies, has been conducted as part of the ongoing environmental studies at Louisiana State University in Shreveport, and other academic and research endeavors of the university.

The Red River floodplain vegetation in and surrounding the Park consists primarily of what has been called "batture" (Lester et al. 2005), "*Populus deltoides* temporary flooded forest alliance" (Weakley 1998), or seasonally flooded river floodplains, and semi-permanently flooded swamps (Van Kley 2006). From one side of the Red River floodplain to the other, the following woody species occur: cottonwood (*Populus deltoides*), green ash (*Fraxinus pennsylvanica*), sycamore (*Platanus occidentalis*), black willow (*Salix nigra*), hackberry (*Celtis laevigata*), boxelder (*Acer negundo*), pecan (*Carya illinoinensis*), rough-leaf dogwood (*Cornus drummondii*), persimmon (*Diospyros virginiana*), mulberry (*Morus rubra*), bois d'arc (*Maclura pomifera*), swamp privet (*Forestiera acuminata*), cypress (*Taxodium distichum*), button bush (*Cephalanthus occidentalis*), honey locust (*Gleditsia triacanthos*), and elm (*Ulmus* spp.). Historically, there were virtually no oaks (*Quercus* spp.), pines (*Pinus* spp.), sweetgum (*Liquidambar styraciflua*), magnolia (*Magnolia grandiflora*), or hickories (*Carya* spp.) other than pecan on the floodplain. The species directly adjacent to the river itself were typically also at the farthest edge of the floodplain just before the uplands are reached. At the floodplain edge, there is an abrupt elevation change (10 to 30 m) and a vegetational transition in which pines (*Pinus*), oaks (*Quercus*), hickories (*Carya*), magnolia (*Magnolia*), and sweetgum (*Liquidambar*) dominate and floodplain species drop out. These species were present in 1830, and they are present today (MacRoberts & MacRoberts 2005). The edge of the floodplain is often marked by a bayou (e.g., Bayou Pierre) just before the uplands and the floristic transition.

METHODS

Beginning in February 2003 and continuing through November 2007, we regularly surveyed the Park for flora by walking through all areas. Specimens were collected, identified using local Floras (e.g., Smith 1994; Diggs et al. 2006), and deposited at Louisiana State University in Shreveport herbarium. Nomenclature generally follows Kartesz and Meacham (2005). We surveyed the Park for community types.

We reviewed the botanical literature for studies of the flora of different land use areas such as parks, research stations, natural areas, counties, states, etc., to obtain data on disturbance and native/exotic ratios. The review was not exhaustive but only meant to sample such areas. We confine our list to studies conducted during the last decade because, as Small and McCarthy (2001) point out, there are an ever increasing number of exotics in the flora.

RESULTS AND DISCUSSION

We found 318 species at the Park, 68 (21%) of which were exotics. These are listed in the Appendix.

The main plant associations that we have separated in the Park are:

Willow forest.—Willow (*Salix*) forest, which sometimes includes sycamore (*Platanus occidentalis*) and cottonwood (*Populus deltoides*), occupies moist to wet soils in periodically flooded river and lake edges and other shallow wet areas. It is this community that colonizes sandbars and other recently scoured areas.

Lake side/inundated non-scoured areas.—This is a continuation of the previous community but is associated with periodically flooded/wet areas such as lake edges and swales. Many species occur in this area including willow (*Salix*), button bush (*Cephalanthus occidentalis*), boxelder (*Acer negundo*), cypress (*Taxodium distichum*), and sycamore (*Platanus occidentalis*) in small numbers. Grasses and sedges and many other

herbaceous plants also occur. Here also is vegetation growing on floating logs, tree stumps, and the base of those woody species that inhabit lake margins, such as button bush.

Open water with floating vegetation.—Duckweed (*Lemna, Spirodela*) sometimes occurs as a continuous green matt on the lake surface. Mosquito fern (*Azolla caroliniana*) can be common. Water-lotus (*Nelumbo lutea*) is dense in one area of the oxbow lake. Coontail (*Ceratophyllum demersum*) and hydrilla (*Hydrilla verticillata*) occur in many areas, usually in shallow water where they can become very dense. Algae sometimes form mats on top of shallow-growing *Ceratophyllum*.

Sandbar.—Because the river is now controlled by dams and locks, natural sandbars do not form. Old aerial photographs show sandbars adjacent to the Park. Willow (*Salix nigra* and *S. exigua*) forest is the community that first colonizes sandbars.

Cottonwood-sycamore-hackberry-ash-pecan forest.—This forest type dominates the middle to higher elevations of the Park, notably the ridges and levees. Any combination of these species, with lesser amounts of honey-locust (*Gleditsia triacanthos*), bois d'arc (*Maclura pomifera*), and boxelder (*Acer negundo*), can occur. Willow is also found here in swales. The understory is predominately rough-leaf dogwood (*Cornus drummondii*). The herbaceous groundcover is sparse, but poison ivy (*Toxicodendron radicans*) and *Juncus* and sedges can be common.

Open (Old) fields.—Open fields make up a large percentage of the Park. These were previously pasture and were planted with legumes and grasses for hay and pasturage. This community contains the highest number of exotic species. The fields typically have scattered cedar (*Juniperus virginiana*), bois d'arc (*Maclura pomifera*), and honey-locust (*Gleditsia triacanthos*).

Ruderal.—The Park contains other areas, such as roads/road sides, mowed areas, ragweed (*Ambrosia trifida*) "forests," and in some places, dodder (*Cuscuta*) covers large areas. These areas are highly disturbed.

We found many studies of undisturbed through highly disturbed sites in which the total flora and number of exotics were given (Table 1). We graph these in Figure 2 by land use type and size of area simply to make the data in Table 1 more accessible.

As we have pointed out, received wisdom is that there is a correlation between percentage of exotics in a flora and site disturbance (McIntyre & Lavorel 1994; Stapanian et al. 1998; Withers et al. 1998; Lonsdale 1999; McKinney 2006; Gilliam 2007 and references therein). Predictors of exotic richness include years of European settlement, disturbance, and surrounding population density (McKinney 2002). Cities present dramatic examples of this with their precipituous loss of native species and gain of exotic species (McKinney 2006). Large areas such as states are highly disturbed and have high percentages of exotics (generally between 15 and 35 percent)(Rejmanek & Randall 1994): eastern Texas, for example, adjacent to Caddo Parish, has 18 percent exotics and Arkansas and Louisiana have 24 and 25 percent, respectively. States along the eastern and western coasts of North America are the most disturbed (longest occupied) and have the most exotics (Withers et al. 1998; Palmer 2008). Pennsylvania, for example, an eastern state much longer occupied by European settlers than eastern Texas, Louisiana, or Arkansas, has 37 percent exotics. County-sized areas tend to have slightly fewer exotics than states but basically rank with them. Madison County, Texas, has 14 percent exotics; Caddo Parish, Louisiana, has 17 percent; Giles County, Tennessee, has 21 percent. Natural areas and nature preserves tend to have fewer exotic species than do state and national parks (4 to 13 percent versus 12 to 17 percent, respectively). Heavily used urban parks have the most exotics (19 to 60 percent). Only very small areas remain without major disturbance and exotics; these are the sites frequently chosen by ecologists to study "natural" communities. Such small areas, often less than a hectare, may show no disturbance and may be entirely free of exotics (0 to 2 percent) even when surrounded by disturbed areas (Gilliam 2007 and references therein).

On the basis of the data in Figure 2, it would appear that only small landscapes remain in natural condition (i.e. without disturbance or exotics). All large landscapes ultimately include disturbed areas and presumably, therefore, exotics. But, size matters little as data on parks suggest: Central Park in New York City has 60% exotics and the tiny Castillo San Marcos Monument has 42%. While it would be ideal to develop

Table 1. Species richness, total area, and percentage of exotics for selected areas.

PARKS	Species	Area (sq km)	exotics %	Source
Central Park, NY	583	3.41	60	DeCandido et al. 2007
Castillo San Marcos Mt, FL	137	0.09	42	Zomlefer & Giannasi 2005
B-D Park, Caddo Parish, LA	318	2.36	21	This study
Middlesex Fells Park, Boston, MA	400	0.69	26	Harcombe et al. 2007
Pelham Bay Park, New York, NY	956		34	Harcombe et al. 2007
Highland Heights Comm.Park, OH	403	0.42	34	Jog et al. 2005
Shaker Median Park, OH	298	1.4	47	Delong et al. 2005
Botany Garden, Houston, TX	446	0.5	19	Harcombe et al. 2007
Mount Vernon, VA	270	0.8	26	Wells & Brown 2000
Fort Washington Nat. Park, MD	973	19.56	25	Steury & Davis 2003
STATES				
Pennsylvania	3318	119236	37	Coxe et al. 2005
Arkansas	3187	153270	24	Diggs et al 2006
Louisiana	3269	134226	25	Thomas & Allen 1993–1998
East Texas	3402	162134	18	Diggs et al. 2006
COUNTIES				
Greene, PN	890	1500	20	Coxe et al. 2005
Oktibbeha, MS	1148	1185	15	Leidolf et al. 2002
Caddo, LA	1405	2283	17	MacRoberts & MacRoberts 2006
Montgomery, AR	1110	2023	12	Marsico 2005
Giles, TN	1208	1582	21	Estes 2005
Coffee, MS	797	1732	16	Martin et al. 2002
Pike, AL	1190	1759	20	Diamond 2003
Yalobusha, MS	805	1305	15	Denley et al. 2002
Madison, TX	1071	1217	14	Neill & Wilson 2001
STATE PARKS				
Myakka River State Park, FL	731	116.86	12	Huffman & Judd 1998
Little Manatee State Park,. FL	523	9.8	17	Myers & Wunderlin 2003
Fall Creek Falls, TN	879	89	13	Fleming & Wooford 2004
NATURAL AREAS				
Turkey Creek, Big Thicket, TX	691	31.5	7	Brown et al. 2005
Hickory Creek, Big Thicket, TX	401	2.8	4	MacRoberts et al. 2002b
Big Sandy Creek, Big Thicket, TX	693	58	7	Brown et al. 2006a
Lance Rosier, Big Thicket, TX	694	101	10	Brown et al. 2006b
Rattlesnake Falls, TN	627	0.63	13	Estes & Walck 2005
Big Branch, LA	563	58.7	13	Rosen et al. 2003
Starkey Wilderness, FL	483	4.49	9	Furguson & Wunderlin 2006
Big Lake Bottom WMA, TX	459	16.85	5	Fleming et al. 2002
Beadle Barrens Preserve, IL	306	0.04	7	Edgin et al. 2005
Dean Hills Nature Preserve, IL	313	0.3	6	Feist et al. 2004
Stephenson Memorial Forest, KY	538	0.51	10	Thompson & Fleming 2004
Ouachita Mountains Biol. Sta., AR	337	1.54	7	MacRoberts et al. 2005
Pushmataha WMA, OK	447	76.9	7	Crandall & Tyrl 2006
Cooters Bog, Vernon Parish, LA	135	0.03	1	MacRoberts & MacRoberts 1993
Big Thicket, Wet Savanna, TX	135	0.06	0	MacRoberts & MacRoberts 1998a
Muck Bog, Anderson Co., TX	136	0.05	2	MacRoberts & MacRoberts 1998b
Kisatchie Prairie, Winn Parish, LA	137	0.03	1	MacRoberts & MacRoberts 1996
Beech Slope, Sabine Co., TX	120	0.03	1	MacRoberts & MacRoberts 1997
Longleaf pine uplands, LA	158	0.004	0	MacRoberts et al. 2002a
Engeling WMA, Anderson Co., TX	930	44.65	6	Singhurst et al. 2003

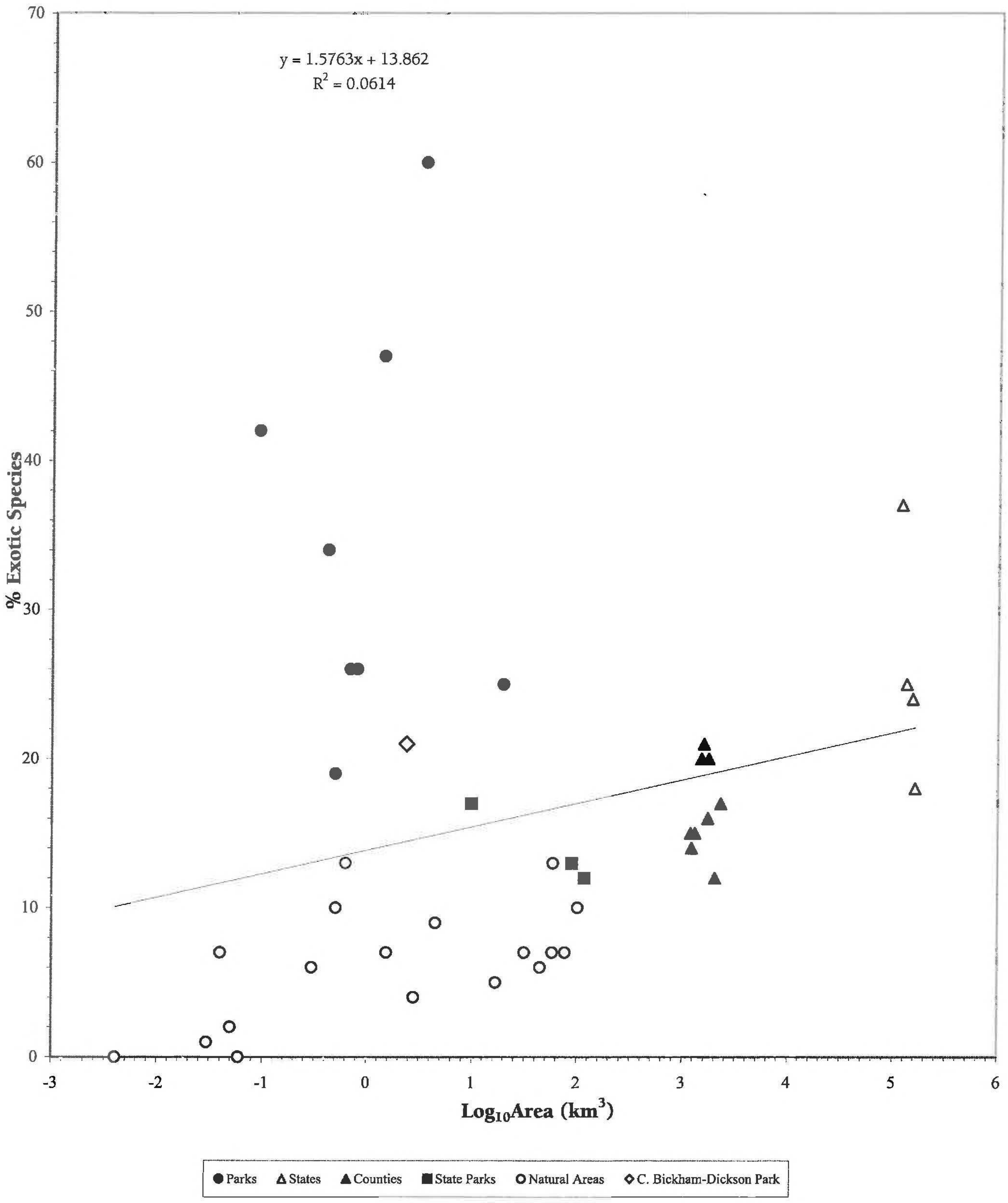

FIG. 2. Relationship of exotic species to area at selective sites. Data from Table 1.

a large data set comparing natural verses disturbed areas, size of area, history and time since disturbance began, the scope of this paper excludes that possibility. Nonetheless, there are such data sets being developed, for example, The Floras of North America project by Michael Palmer at Oklahoma State University (Palmer 2008)(not to be confused with the Flora of North America project) (see also McKinney 2002, 2006 for literature).

In the case of C. Bickham-Dickson/Red River Education and Research Park, the anthropogenic disturbance is great: it was a plantation and horse stables and is now a city park and a research area for a university. It has been cleared of canopy vegetation, and some sections have regenerated canopy. It has been grazed; it has been hayed and plowed. Part of it is mowed. There are old buildings. There are paved and dirt roads. There is a pier, and fishermen use both the bank and boats. Vehicles leave the roads, and off-road vehicles strip the ground of vegetation. Picnickers use the area, as do bird watchers. And the Park is surrounded by an ever increasing urban landscape: suburbs, a university, and lake-front housing. Today, the level and flow of the Red River is artificially controlled by the Corps of Engineers' lock and dam system, and in 2007 and 2008, most of the Park was flooded for several months causing die-off of many plant species not adapted to prolonged submersion. Twenty-one percent of the flora is exotic, a figure at the lower end of parks in our sample (Table 1), but many of these species are aggressive invaders: hydrilla (*Hydrilla verticillata*), Chinese tallow tree (*Sapium sebiferum*), Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), alligator weed (*Alternanthera philoxeroides*), Burmuda grass (*Cynodon dactylon*), and Johnson grass (*Sorghum halepense*).

But the worst is yet to come. In neighboring lakes, ponds, and sloughs other aggressive invaders are poised: giant salvinia (*Salvinia molesta* D.S. Mitch.) has just reached Caddo Parish and is choking nearby lakes; water-lettuce (*Pistia stratiotes* L.), a native of the Gulf coast, has recently arrived in Caddo Parish and undoubtedly will find its way into the Park; water hyacinth (*Eichornia crassipes* (Mart.) Solms) is in the Red River adjacent to the Park and it is only a matter of time before it invades; and brittle water nymph (*Naja minor* All.) has recently been found in Caddo Parish.

Unfortunately, in attempting to reconstruct what has happened to the Park, we do not know its "pristine" ecology and, therefore, what percent of native species has been lost. All we can reconstruct is the native tree flora from the1830s land plat data (MacRoberts & MacRoberts 2005). These data indicate that, while we still have the same native tree species we did in 1830, we also have some new ones, notably exotics such as Chinese tallow tree (*Sapium sebiferum*), silktree (*Albizia julibrissin*), and chinaberry (*Melia azedarach*).

As long as the Park is in a continual state of disturbance largely because of conflicting social interests and thus uses (Corps of Engineers, recreation, homeowners, business, state, city, and university), invasive weeds, native and exotic, will find the area ideal and continue to accumulate to the detriment of native species. Therefore, we can expect the Park to shift farther from a native state to a weedy and exotic state. Whether the current pressure on the Park will result in a catastrophic change in the ecosystems—some would say that it already has—or gradual change, remains unknown (Scheffer et al. 2001; Liu et al. 2007). But that the Park will change is certain, notably if managers attempt drastic intervention; for example, to control aggressive weeds such as hydrilla, when no one knows how much resilience the system has at present or, for that matter, if the system or parts of it has already shifted to a new equilibrium. In that case it will likely be impossible to restore to a previous state (Scheffer et al. 2001).

APPENDIX 1

Vascular plants found at Bickham-Dickson/Red River Education and Research Park. An asterisk * = exotic. Numbers without collector name are collection numbers of B.R. and M.H. MacRoberts. Other collectors are named. Specimens are deposited at Louisiana State University in Shreveport herbarium (LSUS). Common names are in parentheses after collection numbers.

Acanthaceae

Justicia ovata (Walt.) Lindau, 6486 (loose-flower water-willow)

Ruellia caroliniensis (J.F. Gmel.) Steud., 6802 (Carolina wild petunia)

Aceraceae
Acer negundo L., 6014, 6161, 6462, 6831 (boxelder)

Alismataceae
Echinodorus cordifolius (L.) Griseb., 6643, 6796, 6984 (creeping burhead)
Sagittaria graminea Michx., 6233, 6998 (grass-leaf arrowhead)

Amaranthaceae
**Alternanthera philoxeroides* (Mart.) Griseb., 6443 (alligator weed)
Amaranthus hybridus L., 6978 (amaranth)

Anacardiaceae
Toxicodendron radicans (L.) O.Ktze., (not collected) (poision ivy)

Apiaceae
Chaerophyllum tainturieri Hook., 6019 (hairy-fruit chervil)
Cynosciadium digitatum DC., 6447 (finger dogshade)
Hydrocotyle umbellata L., 6229 (many-flower marsh-pennywort)
Hydrocotyle verticillata Thunb., 6645 (whorled marsh-pennywork)
Sanicula canadensis L., 6661 (Canadian black-snakeroot)
**Torilis arvensis* (Huds.) Link, 6426 (spreading hedge-parsley)
Trepocarpus aethusae Nutt. ex DC., 6442, 6449 (whitenymph)

Apocynaceae
Apocynum cannabinum L., 6430, 6969 (Indian hemp)

Aquifoliaceae
Ilex decidua Walt., 6212, 6669 (deciduous holly)
Ilex opaca Ait., 5980 (American holly)

Asteraceae
Acmella oppositifolia (Lam.) R.K. Jansen, 6837 (opposite-leaf spotflower)
Ambrosia artemisiifolia L., 7001 (annual ragweed)
Ambrosia psilostachya DC., 6847, 7000 (perennial ragweed)
Ambrosia trifida L., 6762 (great ragweed)
Baccharis halimifolia L., 6759 (groundseltree)
Bidens laevis (L.) B.S.P., 6987, 6988 (smooth beggarticks)
**Carduus nutans* L., 6489, 6659 (nodding plumeless-thistle)
Chrysopsis pilosa Nutt., 6424 (soft golden-aster)
Conoclinium coelestinum (L.) DC., 6818 (blue mistflower)
Conyza canadensis (L.) Cronq., 6678, 6679, 6779 (Canadian horseweed)
Coreopsis tinctoria Nutt., 6508 (golden tickweed)
Dracopis amplexicaulis (Vahl.) Cass., 6433 (clasping coneflower)
Eclipta prostrata (L.) L., 6835 (false daisy)
Elephantopus carolinianus Raeusch., 6791 (Carolina elephantfoot)
Erigeron philadelphicus L., 6170 (Philadelphia fleabane)
Erigeron strigosus Muhl. ex Willd., 6431, 6675, 7002, 7003 (prairie fleabane)
Eupatorium capillifolium (Lam.) Small, 6778 (dog-fennel)
Eupatorium serotinum Michx., 6795, 6819 (late-flowering thoughtwort)
Gaillardia aestivalis (Walt.) Rock, Burden s.n. (fireweed)
Gaillarida pulchella Foug., 6027 (firewheel)
Gamochaeta pensylvanica (Willd.) Cabrera, 6018 (Pennsylvania everlasting)
Helenium amarum (Raf.) Rock., 6483 (yellowdicks)
Heterotheca subaxillaris (Lam.) Britt. & Rusby, 6677, 6685, 6803, 6825 (camphorweed)
Iva annua L., 6985 (annual marsh-elder)
Krigia caespitosa (Raf.) Chambers, 5972, 7369 (weedy dwarf-dandelion)
Lactuca canadensis L., 6649, 6758 (florida blue-lettuce)
Mikania scandens (L.) Willd., 6634 (climbing hempvine)
Packera obovata (Muhl. ex Willd.) W.A. Weber & A. Love, 5944 (round-leaf groundsel)
Pluchea odorata (L.) Vass., 6787, 6777 (sweetscent)
Pseudognaphalium obtusifolium (L.) Hillard & Burtt., 6849 (blunt-leaf rabbit-tobacco)
Pyrrhopappas pauciflorus (D.Don) DC., 7641, 7360, 6198 (dandelion)
Rudbeckia hirta L., 6481 (black-eyed-susan)
**Senecio vulgaris* L., 5945 (old-man-in-the-spring)
Smallanthus uvedalia (L.) Mackenzie ex Small, 7180 (bear's-foot)
Solidago canadensis L. var. *scabra* Torr. & Gray, 6832, 6951 (Canadian goldenrod)
**Sonchus asper* (L.) Hill, 5936, 5957 (spiny-leaf sow-thistle)
Symphyotrichum lateriflorum (L.) A. & D. Love, 6957, 6972 (American aster)
Symphyotrichum racemosum (Ell.) Nesom, 6999 (fragile-stem American aster)
Symphyotrichum subulatum (Michx.) Nesom, 6821, 6965 (seaside American aster)
**Taraxacum officinale* G.H. Weber ex Wiggers, 5960 (common dandelion)
Vernonia baldwinii Torr., 6798 (western ironweed)
Xanthium strumarium L., 6226, 6661, 6663 (cockleburr)

Azollaceae
Azolla caroliniana Willd., 5935 (Carolina mosquito fern)

Berberidaceae
**Nandina domestica* Thunb., 6465 (sacred-bamboo)

Bignoniaceae
Campsis radicans (L.) Seem. ex Bureau, 6179, 6652 (trumpet creeper)

Boraginaceae
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Myosotis macrosperma Engelm., 6155, 6007, 7367 (large-seed forget-me-not)

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**Capsella bursa-pastoris* (L.) Medik., 5939, 5958 (shepherd's purse)
Lepidium virginicum L., 6421 (poorman's-pepperwort)
Sibara virginica (L.) Rollins, 5938 (Virginia winged-rockcress)

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Triodanis perfoliata (L.) Nieuwl., 6025, 6422 (clasping-leaf Venus'-looking-glass)

Caprifoliaceae

**Lonicera japonica* Thunb., 6192 (Japanese honeysuckle)
Sambucus nigra L., 6188, 6660 (black elder)

Caryophyllaceae

**Arenaria serpyllifolia* L., 6034 (thyme-leaf sandwort)
**Cerastium glomeratum* Thuill., 5940, 5964 (sticky mouse-ear chickweed)
Sagina decumbens (Ell.) T. & G., 5968, 6032 (trailing pearl-wort)
**Stellaria media* (L.) Vill., 5965 (common chickweed)

Ceratophyllaceae

Ceratophyllum demersum L., 6956 (coon's-tail)

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Cornaceae

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Cucurbitaceae

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Cupressaceae

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Cuscuta indecora Choisy, 6807, 6841 (large-seed dodder)

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Carex crus-corvi Schuttlew. ex Kunze, 6438 (raven-foot sedge)
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Carex flaccosperma Dewey, 6184, 6217, 6008, 6162 (thin-fruit sedge)
Carex frankii Kunth, 6833 (Frank's sedge) [*C. aureolensis* Steud. FNA]
Carex leavenworthii Dewey, 6021, 6154 (Leavenworth's sedge)
Carex retroflexa Muehl. ex Willd., 6174 (reflexed sedge)
Cyperus acuminatus Torr. & Hook. ex Torr., 6450, 6492, 6636 (taper-tip flat sedge)
Cyperus croceus Vahl., 6492, 6630, 6671, 6677, 6834 (Baldwin's sedge)
**Cyperus difformis* L., 6993 (variable flat sedge)
Cyperus erythrorhizos Muhl., 6644 (red-foot flat sedge)
Cyperus esculentus L., 6857 (chufa)
Cyperus odoratus L., 6839, 6782, 6983 (rusty flat sedge)
**Cyperus rotundus* L., 6425 (purple flat sedge)
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Ebenaceae

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Equisetaceae

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Chamaesyce prostrata (Ait.) Small, 6958 (prostrate sandmat)
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**Euphorbia helioscopia* L., 5961 (mad-woman's-milk)
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**Medicago polymorpha* L., 6031 (tooth medick)
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**Geranium dissectum* L., 6159, 7362 (cut-leaf crane's-bill)

Hydrocharitaceae
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Iridaceae
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Juncaceae
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Juncus dichotomous Ell., 6182 (forked rush)
Juncus marginatus Rostk., 6432, 6493 (grass-leaf rush)

Lamiaceae
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**Lamium purpureum* L., 5967 (red henbit)
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Lemnaceae
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Spirodela sp., 6234, 6860 (duckmeat)
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Lentibulariaceae
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Liliaceae
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**Liriope muscari* (Dcne) Bailey, 6829 (big blue lilyturf)
**Narcissus* sp., 5955 (daffodil)
Nothoscordum bivalve (L.) Britt., 5943 (crowpoision)

Loganiaceae
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Lythraceae
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Lythrum alatum Pursh, 6783 (wing-angle loosestrife)

Malvaceae
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Hibiscus moscheutos L., 6639 (crimson-eyed rose-mallow)
**Sida rhombifolia* L., 6647(tea weed)
Sida spinosa L., 6641, 6785 (prickly fanpetals)

Meliaceae
**Melia azedarach* L., 6183 (china-berry)

Menispermaceae
Cocculus carolinus (L.) DC., 6469, 6658, 6971 (Carolina coralbean)

Molluginaceae
**Mollugo verticillata* L., 6810, 8063 (green carpetweed)

Moraceae
Maclura pomifera (Raf.) Schneid., 6191 (bois d'arc)
**Morus alba* L., 5996, 6194, 7358 (white mulberry)
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Myricaceae
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Nelmbonaceae
Nelumbo lutea (Willd.) Pers., 7428 (yellow-lotus)

Oleaceae
Forestiera acuminata (Michx.) Poir., 6214 (swamp-privit)
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Ludwigia leptocarpa (Nutt.) Hara., 6786, 6836, 8058 (angle-stem primose-willow)
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Ludwigia repens J.R. Forest., 6633 (creeping primose-willow)
Oenothera biennis L., 6794 (King's cureall)
Oenothera laciniata Hill., 5995, 6171, 7366 (cut-leaf evening-primrose)
Oenothera speciosa Nutt., 6434, 7365 (pinkladies)

Ophioglossaceae
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Orchidaceae
Spiranthes laciniata (Small) Ames, 6500 (lace ladies-tresses)

Oxalidaceae
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Passifloraceae
Passiflora incarnata L., 6970 (purple passion-flower)

Phytolaccaceae
Phytolacca americana L., 6761 (pokeweed)

Pinaceae
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Plantaginaceae
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Plantago heterophylla Nutt., 6023 (slender plantain)
Plantago virginica L., 5994 (pale-seed plantain)

Platanaceae
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Poaceae
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Panicum dichotomiflorum Michx., 6680, 6966, 6842 (fall panic grass)
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Paspalum setaceum Michx., 6501, 6505 (slender crown grass)
Paspalum urvillei Steud., 6974 (Vasey's grass)
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Setaria pumila (Poir.) Roemer & Schutes, 6418, 6973 (yellow bristle grass)
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Triticum aestivum L., 6485 (bread wheat)
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Polygonaceae

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Polygonum setaceum Baldw., 6642 (bog smartweed)
Polygonum virginianum L., 6830 (jumpseed)
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Portulaceaceae

Portulaca oleracea L., 6784 (little-hogweed)

Potamogetonaceae

Potamogeton nodosus Poir., 6632, 6666 (long-leaf pondweed)

Primulaceae

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Ranunculaceae

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Rhamnaceae

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Rosaceae

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Prunus angustifolia Marsh., 5987 (Chickasaw plum)
Pyrus calleryana Dcne., 5976 (Bradford pear)
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Galium tinctorium (L.) Scop., 6428 (stiff marsh bedstraw)
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Spermacoce glabra Michx., 6668 (smooth false buttonweed)

Rutaceae

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Salicaceae

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Sapindaceae

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Saururaceae
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Scrophulariaceae
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Mecardonia acumnata (Walt.) Small, 6853 (axil-flower)
Mimulus alatus Ait., 6799 (sharp-wing monkey-flower)
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**Veronica arvensis* L., 5970 (corn speedwell)
Veronica peregrina L., 5946, 5973, 7371 (neckweed)
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Smilacaceae
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Solanaceae
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Solanum carolinense L., 6419 (Carolina horse-nettle)
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Typhaceae
Typha latifolia L., 7451 (cat-tail)

Ulmaceae
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Ulmus americana L., 6001 (American elm)

Urticaceae
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Valerianaceae
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Verbenaceae
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**Verbena brasiliensis* Vell., 6471 (Brazilian vervain)
Verbena halei Small, 6423, 6804 (Texas vervain)
Verbena urticifolia L., 6792 (white vervain)

Violaceae
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Viola sagittata Ait., 6006 (arrow-leaf violet)

Vitaceae
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Vitis riparia Michx., 6189, 6197, 6986, 5997 (river-bank grape)

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REFERENCES

Advisory Committee Report. 2002. Red River Education and Research Park. Unpublished manuscript. LSUS/City of Shreveport.

Bagur, J.D. 2001. A history of navigation on Cypress Bayou and the lakes. Univ. North Texas Press, Denton, Texas.

Basinger, M.A., J.S. Huston, R.J. Gates, and P.A. Robertson. 1997. Vascular flora of Horseshoe Lake Conservation Area, Alexander County, Illinois. Castanea 62:82–99.

Bragg, D.C. 2008. The prominence of pine in the Upper West Gulf Coastal Plain during historical times. In: L.M. Hardy, ed. Freeman and Custis Red River expedition of 1806: two hundred years later. Bull. Mus. Life Sci. 14:29–54.

Brown, L.E., B.R. MacRoberts, M.H. MacRoberts, P.A. Harcombe, W.W. Pruess, I.S. Elsik, and D. Johnson. 2005. Annotated checklist of the vascular flora of the Turkey Creek Unit of the Big Thicket National Preserve, Tyler and Hardin counties, Texas. Sida 21:1807–1827.

Brown, L.E., B.R. MacRoberts, M.H. MacRoberts, P.A. Harcombe, W.W. Pruess, I.S. Elsik, and S.D. Jones. 2006a. Annotated checklist of the vascular flora of the Big Sandy Creek Unit, Big Thicket National Preserve, Texas. Sida 22:705–723.

Brown, L.E., B.R. MacRoberts, M.H. MacRoberts, P.A. Harcombe, W.W. Pruess, I.S. Elsik, and S.D. Jones. 2006b. Annotated checklist of the vascular flora of the Lance Rosier Unit of the Big Thicket National Preserve, Hardin County, Texas. Sida 22:1175–1189.

Coxe, R., C.M. Morton, M.J. Haywood, B.L. Isaac, and J.A. Isaac. 2005. Checklist of the vascular plants of Greene County, Pennsylvania. Sida 21:1829–1859.

Crandall, R.M. and R.J. Tyrl. 2006. Vascular flora of the Pushmataha Wildlife Management Area, Pushmataha County, Oklahoma. Castanea 71:65–79.

DeCandido, R., N. Calvanese, R.V. Alverez, M.I. Brown, and T.M. Nelson. 2007. The naturally occurring historical and extant flora of Central Park, New York City, New York 1857–2007. J. Torrey Bot. Soc. 134:552–569.

Delong, M.K., K.K. Jog, J.R. Johansen, and G.L. Wilder. 2005. Floristic survey of a highly disturbed wetland within Shaker Median Park, Beachwood (Cayahoga County), Ohio. Ohio J. Sci. 105:102–105.

Denley, K.K., C.T. Bryson, and R.A. Stewart. 2002. Vascular flora of Yolobusa County, Mississippi. Castanea 67: 402–415.

De Villiers, M. 2000. Water: the fate of our most precious resource. Houghton Mifflin, New York.

Diamond, A.R. 2003. A checklist of the vascular flora of Pike County, Alabama. Castanea 68:143–159.

Diggs, G.M., B.L. Lipscomb, M.D. Reed, and R.J. O'Kennon. 2006. Illustrated flora of east Texas. Sida, Bot. Misc. 26: 1–1594.

Edgin, B.R., R. Beadles, and J.E. Ebinger. 2005. Vascular flora of Beadles Barrens Nature Preserve, Edwards County, Illinois. Castanea 70:47–58.

Elton, C.S. 1958. The ecology of invasions by animals and plants. London: Methuen.

Estes, D. 2005. The vascular flora of Giles County, Tennessee. Sida 21:2343–2388.

Estes, D. and J.L. Walck. 2005. The vascular flora of Rattlesnake Falls: a potential state natural area on the western highland rim escarpment in Tennessee. Sida 21:1753–1780.

Feist, M.A., L.R. Phillippe, D.T. Busemeyer, and J.E. Ebinger. 2004. Vegetation survey of Dean Hills Nature Preserve, Fayette County, Illinois. Castanea 69:52–66.

Ferguson, E. and R.P. Wunderlin. 2006. A vascular plant inventory of Starkey Wilderness Preserve, Pasco County, Florida. Sida 22: 635–659.

Fleming, C.A. and B.E. Wofford. 2004. The vascular flora of Fall Creek Falls State Park, Van Buren and Bledsoe counties, Tennessee. Castanea 69:164–184.

Fleming, K.M., J.R. Singhurst, and W.C. Holmes. 2002. Vascular flora of Big Lake Bottom Wildlife management Area, Anderson County, Texas. Sida 20:355–371.

Flores, D.L. 1984. Jefferson and southwestern exploration: the Freeman and Custis accounts of the Red River expedition of 1806. Univ. Oklahoma Press, Norman, Oklahoma.

Fox, M.D. and B.J. Fox. 1986. The susceptibility of natural communities to invasion. In: R.H. Groves and J.J. Burdin, eds. Ecology of biological invasions. Cambridge Univ. Press, New York. Pp. 57–66.

Gilliam, F.S. 2007. The ecological significance of the herbaceous layer in temperate forest ecosystems. BioScience 57:845–859.

Harcombe, P.A., I.S. Elsik, W.W. Pruess, and L.E. Brown. 2007. The vascular flora of a woodland park site in east Harris County, Texas. J. Bot. Res. Inst. Texas 1:693–711.

Hardy, L.M. (ed.) 2008. The Freeman and Custis Red River Expedition of 1806: two hundred years later. Bull. Museum of Life Sciences 14:1–368.

Henderson State University Biology Department. 1979. Biological inventory of the Red River waterway from Index, Arkansas to Shreveport, Louisiana. U.S. Corps of Engineers, New Orleans District.

Henrici, H.H. 1985. Shreveport, the beginning. Center for Louisiana Studies, Univ. Southwestern Louisiana, Lafayette, Louisiana.

Huffman, J.M. and W.S. Judd. 1998. Vascular flora of Myakka River State Park, Sarasota and Manatee counties, Florida. Castanea 63:25–50.

Humphreys, H. 1971. Photographic views of Red River raft, 1873. Louisiana History 12:101–108.

Jog, S.K., J.T. Kartesz, J.R. Johansen, and G.J. Wilder. 2005. Floristic study of Highland Heights Community Park, Cuyahoga County, Ohio. Castanea 70:136–145.

Kartesz, J.T. and C.A. Meacham. 2005. Synthesis of North American flora. Version 2.0. North Carolina Botanical Garden, Chapel Hill.

Leidolf, A., S. McDaniel, and T. Nuttle. 2002. Flora of Oktibbeha County, Mississippi. Sida 20:691–765.

Lester, G.D., S.G. Sorensen, P.L. Faulkner, C.S. Reid, and I.E. Maxit. 2005. Louisiana comprehensive wildlife conservation strategy. Louisiana Natural Heritage Program. Louisiana Department of Wildlife and Fisheries. Baton Rouge, Louisiana.

Liu, J. (and 15 others). 2007. Complexity of coupled human and natural systems. Science 317:1513–1516.

Lonsdale, W.M. 1999. Global patterns of plant invasions and the concept of invasibility. Ecology 80:1522–1536.

McIntyre, S. and S. Lavorel. 1994. Predicting richness of native, rare, and exotic plants in response to habitat and disturbance variables across a variegated landscape. Conservation Biol. 8:521–531.

McKinney, M.L. 2002. Influence of settlement time, human population, park shape and age, visitation and roads on the number of alien plant species in protected areas in the USA. Diversity & Distrib. 8:311–318.

McKinney, M.L. 2006. Urbanization as a major cause of biotic homogenization. Biol. Conservation 127:247–260.

MacRoberts, B.R. and M.H. MacRoberts. 1993. Floristics of a bog in Vernon Parish, Louisiana, with comments on noteworthy bog plants in western Louisiana. Phytologia 75:247–258.

MacRoberts, B.R. and M.H. MacRoberts. 1996. Floristics of calcareous prairies on the Kisatchie National Forest, Louisiana. Phytologia 81:35–43.

MacRoberts, B.R. and M.H. MacRoberts. 1997. Floristics of beech-hardwood forest in east Texas. Phytologia 82:20–29.

MacRoberts, B.R. and M.H. MacRoberts. 1998a. Floristics of wetland pine savannas in the Big Thicket National Preserve, southeast Texas. Phytologia 85:40–50.

MacRoberts, B.R. and M.H. MacRoberts. 1998b. Floristics of muck bogs in east central Texas. Phytologia 85:61–73.

MacRoberts, B.R. and M.H. MacRoberts. 2006. An updated, annotated vascular flora of Caddo Parish, Louisiana, with notes on regional phytogeography and ecology. Sida 22:1191–1219.

MacRoberts, B.R. and M.H. MacRoberts. 2008a. Plant ecology and phytogeography of the West Gulf Coastal Plain: an overview. In: L.M. Hardy, ed. Freeman and Custis Red River expedition of 1806: two hundred years later. Bull. Mus. Life Sci. 14:7–28.

MacRoberts, B.R., M.H. MacRoberts, and L.S. Jackson. 2002a. Floristics of upland longleaf pine savanna in central Louisiana. Proc. Louisiana Acad. Sci. 65:1–13.

MacRoberts, B.R., M.H. MacRoberts, and L.E. Brown. 2002b. Annotated checklist of the vascular flora of the Hickory Creek Unit of the Big Thicket National Preserve, Tyler County, Texas. Sida 20: 781–795.

MacRoberts, B.R., M.H. MacRoberts, and T.D. Marsico. 2005. Preliminary survey of the vascular flora of the Ouachita Mountains Biological Station, Polk County, Arkansas. Bull. Mus. Life Sci. 13:1–19.

MacRoberts, D.T. 1979. Checklist of the plants of Caddo Parish, Louisiana. Bull. Mus. Life Sci., Louisiana State University-Shreveport 1:1–54.

MacRoberts, D.T., B.R. MacRoberts, and M.H. MacRoberts. 1997. A floristic and ecological interpretation of the Freeman and Custis Red River expedition of 1806. Bull. Mus. Life Sci., Louisiana State University-Shreveport 12:1–26.

MacRoberts, M.H. and B.R. MacRoberts. 2004. About 450 miles up the Red River in a large prairie: Peter Custis' surviving botanical information from the Red River expedition of 1806. Sida 21:963–975.

MacRoberts, M.H. and B.R. MacRoberts. 2005. Reference conditions of the Red River floodplain and upland, Caddo Parish, Louisiana. Sida 21:1793–1806.

MacRoberts, M.H. and B.R. MacRoberts 2008b. West Gulf Coastal Plain botanical ecology: Ice Age to present. In: L.M. Hardy, ed. Freeman and Custis Red River expedition of 1806: two hundred years later. Bull. Mus. Life Sci. 14:55–79.

Mann, C.C. 2005. 1491: new revelations of the Americas before Columbus. Knopf, New York, New York.

Marcy, R.B. and G.B. McClellan. 1854. Exploration of the Red River in Louisiana 1852. Beverly Tucker, Senate Printer, Washington, D.C.

Marsico, T.D. 2005. The vascular flora of Montgomery County, Arkansas. Sida 21: 2389–2423.

Martin, B.H., M. Woods, and A.R. Diamond. 2002. The vascular flora of Coffee County, Alabama. Castanea 67:227–246.

McKinney, M.L. 2002. Influence of settlement time, human population, park shape and age, visitation and roads on the number of alien plant species in protected areas in the USA. Diversity & Distrib. 8:311–318.

McKinney, M.L. 2006. Urbanization as a major cause of biotic homogenization. Biol. Conservation 127:247–260.

McIntyre, S. and S. Lavorel. 1994. Predicting richness of native, rare, and exotic plants in response to habitat and disturbance variables across a variegated landscape. Conservation Biol. 8:521–531.

Messina, M.G. and W.H. Conner. 1998. Southern forested wetlands: ecology and management. Lewis Publ., New York, New York.

Meyers, J.H. and R.P. Wunderlin. 2003. Vascular flora of Little Manatee State Park, Hillsborough County, Florida. Castanea 68:56–74.

Mitsch, W.J. and J.G. Gosselink. 2000. Wetlands. 3rd ed. John Wiley & Sons, New York, New York.

Mundorff, K.T. 1998. Ecological classification of bottomland hardwood forests in east Texas and central Louisiana. M.S. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

Neill, A.K. and H.D. Wilson. 2001. The vascular flora of Madison County, Texas. Sida 19:1083–1121.

Newkirk, J.A. and J.W. Mueller. 1980. Cultural resources survey of the Red River waterway from Shreveport to the Mississippi River. Rept. 2021. Commonwealth Association Inc., Jackson, Michigan.

Noss, R.F., E.T. LaRoe, and J.M. Scott. 1995. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. Biological Report 28: USDI National Biological Service, Washington D.C.

O'Pry, M.H. 1928. Chronicles of Shreveport. Journal Printing Co. Shreveport, Louisiana.

Outwater, A. 1996. Water: a natural history. Basic Books, New York.

Palmer, E.J. 1923. The Red River forest at Fulton, Arkansas. J. Arnold Arbor. 4:8–33.

Palmer, M. 2008. The floras of North America project. www.okstate.edu/artsci/botany/floras.

Perttula, T.K., D.B. Lee, and R. Cast. 2008. The first people of the Red River: the Caddo before and after Freeman and Custis. In: L.M. Hardy, ed. Freeman and Custis Red River expedition of 1806: two hundred years later. Bull. Mus. Life Sci. 14:81–110.

Rejmanek, M. and J.M. Randall. 1994. Invasive alien plants in California: 1993 summary and comparison with other areas in North America. Madrono 41:161–177.

Rosen, D.J., S.D. Jones, and V.E. Rettig. 2003. A floristic survey of Big Branch Marsh National Wildlife Refuge, St. Tammany Parish, Louisiana. Sida 20:1189–1216.

Sax, D.F., J.J. Stachowicz, and S.D. Gains. 2005. Species invasions: insights into ecology, evolution, and biogeography. Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts.

Scheffer, M., S. Carpenter, J.A. Foley, C. Folkes, and B. Walker. 2001. Catastrophic shifts in ecosystems. Nature 413:591–596.

Sexton-Gordon, A. 2004. River of data. Louisiana Research (spring):28–32.

Sharitz, R.R. and W.J. Mitsch. 1993. Southern floodplain forests. In: W.H. Martin, S.G. Boyce, and A.C. Echternacht, eds. Biodiversity of the southeastern United States: lowland terrestrial communties. John Wiley and Sons, New York. Pp. 311–372.

Simberloff, D. 2004. A rising tide of species and literature: a review of some recent books on biological invasions. BioScience 54:247–254.

Singhurst, J.R., J.C. Cathey, D. Prochaska, H. Hauke, G.C. Kroh, and W.C. Holmes. 2003. The vascular flora of Gus Engeling Wildlife Management Area, Anderson County, Texas. S.E. Naturalist 2:347–368.

Small, C.J. and B.C. McCarthy. 2001. Vascular flora of the Waterloo Wildlife Research Station, Athens County, Ohio. Castanea 66:363–382.

Smith, E.B. 1994. Keys to the flora of Arkansas. Univ. Arkansas Press, Fayetteville.

Stalter, R., E.E. Lamont, and D.T. Kincaid. 1997. Non-native plants at Fisherman Island, Virginia, a twenty year comparison. Castanea 62:268–271.

Stapanian, M.A., S.D. Sundberg, G.A. Baumgarden, and A. Liston. 1998. Alien plant species composition and associations with anthropogenic disturbance in North American forests. Pl. Ecol. 139:49–62.

Steury, B.W. and C.A. Davis. 2003. The vascular flora of Piscataway and Fort Washington National Parks, Prince Georges and Charles counties, Maryland. Castanea 68:271–299.

Stuckey, R.L. and T.M. Barkley. 1991. Weeds. In: Flora of North American Committee, eds. Flora of North America. Vol 1. Oxford University Press, New York and Oxford. Pp. 193–198.

Teague, J. and T. Wendt. 1994. Caddo and Bossier parishes: natural areas survey. The Nature Conservancy, Baton Rouge, Louisiana.

Thomas, R.D. and C.M. Allen. 1993–1998. Atlas of the vascular flora of Louisiana. 3 vols. Louisiana Department of Wildlife and Fisheries and The Nature Conservancy, Baton Rouge.

Thompson, R.L. and C.A. Fleming. 2004. Vascular flora and plant communities of the John B. Stephenson memorial Forest State Nature Preserve, Rockcastle County, Kentucky. Castanea 69:125–135.

Triska, F.J. 1984. Role of wood debris in modifying channel geomorphology and riparian areas of a large lowland river under pristine conditions: a historical case study. Verh. Int. Vereinigung Limnol. 22:1876–1892.

Triska, F.J. 2008. Ecology and history of the Red River raft. In: L.M. Hardy, ed. Freeman and Custis Red River expedition of 1806: two hundred years later. Bull. Mus. Life Sci. 14:307–323.

U.S.D.A. Soil Conservation Service. 1959. Soil Survey, Bossier Parish, Louisiana. U.S.D.A. Soil Conservation Service. Louisiana Agricultural Experiment Station.

Van Kley, J.E. and D.N. Hine. 1998. The wetland vegetation of Caddo Lake. Texas J. Sci. 50:267–290.

Van Kley, J.E. 2006. The pineywoods. In: G.M. Diggs, B.L. Lipscomb, M.D. Reed, and R.J. O'Kennon, eds. Illustrated flora of east Texas, Pp. 76–106. Sida, Bot. Misc. 26:1–1594.

Ware, G.H. 1956 Vegetational zonation on a Red River sand bar near Natchitoches, Louisiana. Proc. Louisiana Acad. Sci. 19:21–24.

Weakley, A.S., K.D. Patterson, S. Landall, and M. Pyne. 1998. International classification of ecological communities: terrestrial vegetation of the southeastern United State. Working Draft. The Nature Conservancy, Chapel Hill, North Carolina.

Withers, M.A., M.W. Palmer, G.L. Wade, P.S. White, and P.R. Neal. 1998. Changing patterns in the number of species in North American floras. In: T.D. Sisk, ed. Perspectives on the land use history of North America: a context for understanding our changing environment. U.S. Geological Survey, Biological Resources Division. Reston, Virginia. Pp. 23–32.

Wells, E.F. and R.L. Brown. 2000. An annotated checklist of the vascular plants in the forest at Historic Mount Vernon, Virginia: a legacy from the past. Castanea 65:242–257.

Zomlefer, W.B. and D.E. Giannasi. 2005. Floristic survey of Castillo de San Marcos National Monument, St. Augustine, Florida. Castanea 70:222–236.